Chapter 5

Facilities and Experimental Layout

The BRAHMS Experiment requires a substantial area to meet the spatial requirements of its two spectrometer arms. Both the 4-O'clock and 2-O'clock intersection regions have been identified as possible experimental sites. In the following, we first consider the 4-O'clock location in some detail: historically, this was an early selection, but more importantly, it requires special considerations because of the RF cavities located at this intersection. Minor modifications necessary to locate BRAHMS at the 2-O'clock intersection, where the RF problem is absent, are given in a later subsection (5.7). In the following, we first discuss the physical layout of the experiment at the 4-O'clock area. The required resources for the experiment will be presented and interfacing issues with various collider components will be discussed. Finally, several potential upgrades to the facilities at the 4-O'clock area will be proposed.

A plan view of the experiment in the 4 O'clock hall is shown in Fig. 5.1. The mid-rapidity spectrometer is shown both at 90° and at its most forward angle of 20°. The complete forward angle spectrometer is shown at its most forward angle of 2° and largest angle of 20°. The back section is not needed for larger angles, but the forward section will operate to angles of 35° and is also shown in this setting. The shield walls have been sited to allow for the movement of the spectrometers, personnel access, and the addition of support electronics. The close proximity of the forward spectrometer to the beam pipe and DX is obvious. Issues of possible conflict will be discussed later. The required movement of the spectrometers to cover the desired p_t and rapidity ranges, coupled with the magnet and detector design, establishes the size of the experimental area.

There are several considerations which lead to the spectrometer layout as shown in Fig. 5.1. Many of the projectile fragmentation products will interact with the beam pipe between DX and D0. The forward spectrometer has been sited on the side of the accelerator opposite from where the fragmentation products will be bent by DX. This provides additional distance and angle to shield the detectors from the interactions in the beam pipe. The experiment intends to occasionally operate both spectrometers with simultaneous coverage of the same region of phase space in order to study potential systematic effects. The experiment expects that it will be necessary to maintain the largest distance possible between the spectrometers and the RF cavities which also limits the spectrometers to that side of the IR opposite to the RF cavities. The above considerations lead to the layout shown. This arrangement also satisfies criteria established for unequal mass beams, in that both spectrometer arms operate in the region of positive rapidities for the light projectile. The proposed layout is compatible with this requirement and the orientation of PHENIX.

5.1 Shielding layout

The shielding for the experimental area has been shown in Fig. 5.1. Six-foot thick light-concrete walls have been used to reduce the dose from a full beam fault (at four times day one intensity) to less than 500 mrem for personnel outside the side wall. This is based on calculations (RHIC Note 5) which do not include massive objects located near the beam line. The close proximity of magnets when operating at forward angles may require a more careful calculation of the side wall shielding. The roof span over the experiment has been chosen to meet the requirements of the experiment and also to take advantage of available roof beams at the AGS. Fault levels through the roof will be approximately 10 times higher than the side wall, dictating that personnel should be excluded from this area. The higher radiation levels are a result of the thinner roof (four feet thick) and the smaller distances. Two access ports on each side of the area to accommodate the magnet transporter are shown. In addition, a labyrinth to allow for easy access of personnel and small equipment has been designed into the shield wall. The shielding height will need to be approximately 20 ft. to accommodate a gantry crane which would operate over the experiment but underneath the shielding roof. The shielding arrangement will continue to evolve to accommodate both the experimental and accelerator requirements.

5.2 Support Buildings

The BRAHMS Experiment will require two support buildings. The first is a counting house of approximately 1200 square feet. This area is expected to be sufficient if the electronics are distributed on the platforms with the detectors. The second is a building for the magnet power supplies and gas handling controls. These buildings are shown in Fig. 5.2. Consideration of safety, audible noise, and electrical isolation has led us to use separate structures at this stage of the design. The power supply area (900 ft^2) is large enough to accommodate air cooled power supplies on a single floor. It is intended that a small, separate section of this latter building be used to house the gas-control systems necessary for the various particle-detector elements of the spectrometers.

These two buildings have been sited on the inside of the accelerator ring near the center of the open area. This minimizes cable distances to the experiment and allows for convenient access. The outside of the experimental pad has been ruled out since there is no vehicle access, once the shielding walls are in place. Finally, it is anticipated that the utilities (power and water) will originate from inside the RHIC ring. These buildings and the two access areas for the RHIC magnet transporter use most of the available space along the 4 O'Clock area.

5.3 RF cavities and the experiment

Four storage RF cavities are planned for the four O'clock area as shown in in Fig. 5.2. There are important considerations on the compatability of the experiment and the RF cavities. A shield wall intended to protect personnel from the x-rays generated by the cavities is shown. It is anticipated that there will be occasions when it is desired to operate the RF cavities while the experiment desires access. This will be particularly true during the construction phase and during conditioning of the RF. A 30 inch concrete wall has been used to reduce the potential 100 rad/hr levels to 1 mrem/hr during conditioning of the cavities. A shield of 8 inches of iron is shown near the beam pipe. This arrangement is preliminary, representing a first-order attempt to address this problem.

The operations of the RF cavities may also create an undesirable environment for the experiment. The RF broadcast noise may induce undesired signals in the detectors and responses in the electronics. The generated x-rays may cause induced signals in the beam counters at unacceptable levels. Finally, the increased pressure bump in the cavities may increase beam-gas interactions to an intolerable level. The experiment will work in conjunction with RHIC personnel to examine these potential problems and solutions which can be implemented.

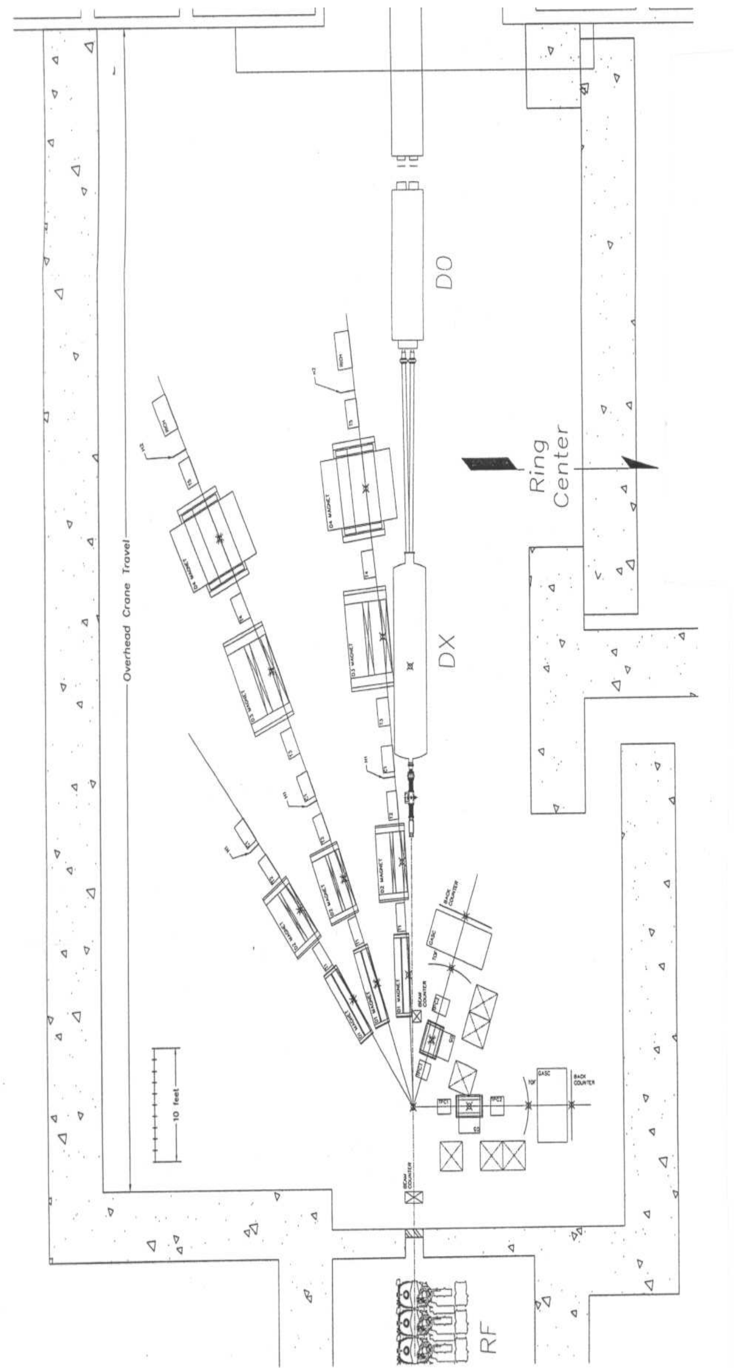

Figure 5.1: Detail of BRAHMS at the 4 O'clock area. The forward and midrapidity spectrometer arms are shown at different angular settings within their ranges. The magnet and detector elements of each are identified, as well as the BEAM-BEAM counters. Their positioning relative to elements of RHIC, in particular the RF-cavities and magnets DX and D0, is discussed in the text.

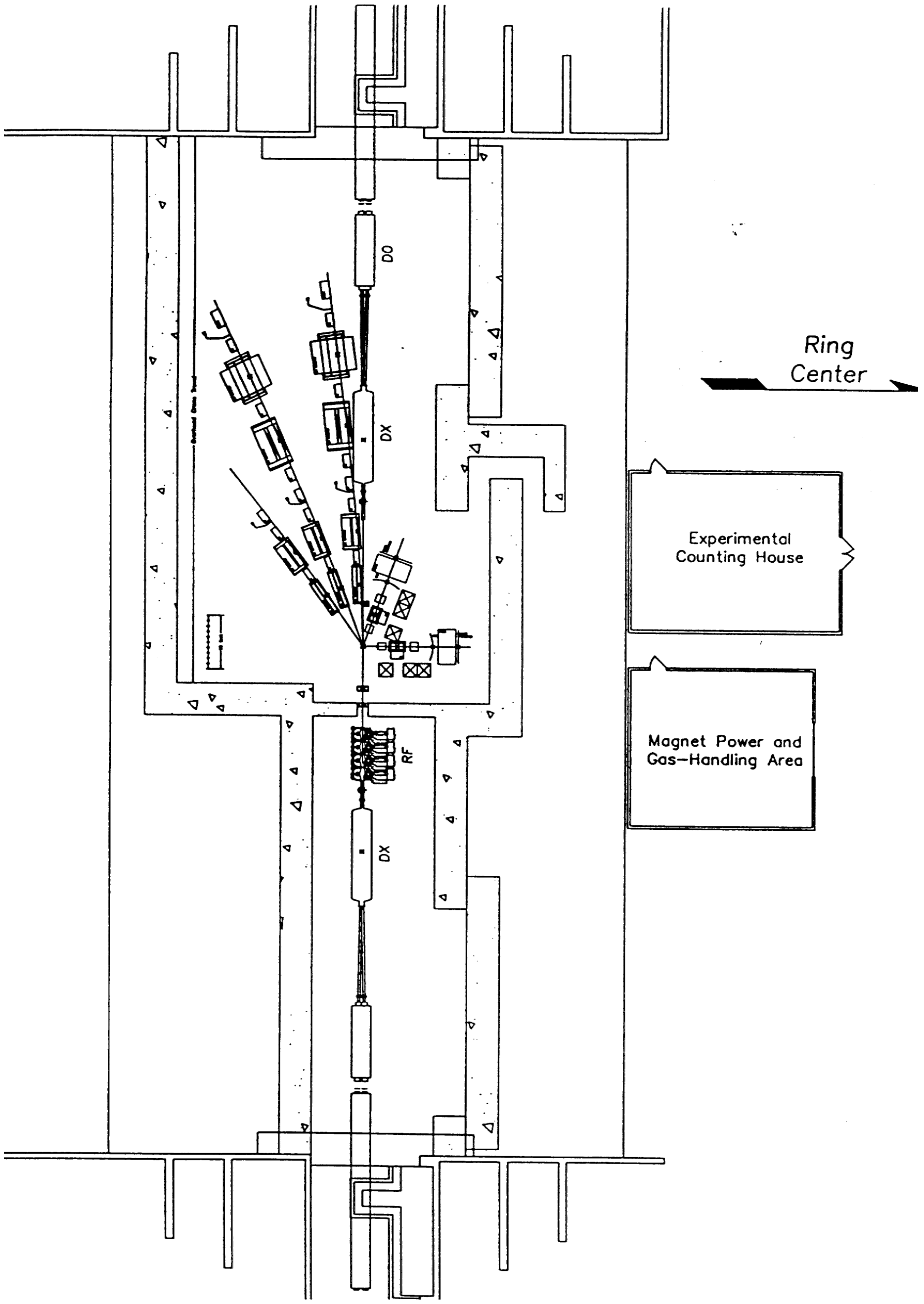

Figure 5.2: Bird's eye view of BRAHMS at the 4 O'clock area The relationship of BRAHMS to the elements of the RHIC accelerator and shielding walls is shown, as are also the two auxiliary buildings needed for the experiment.

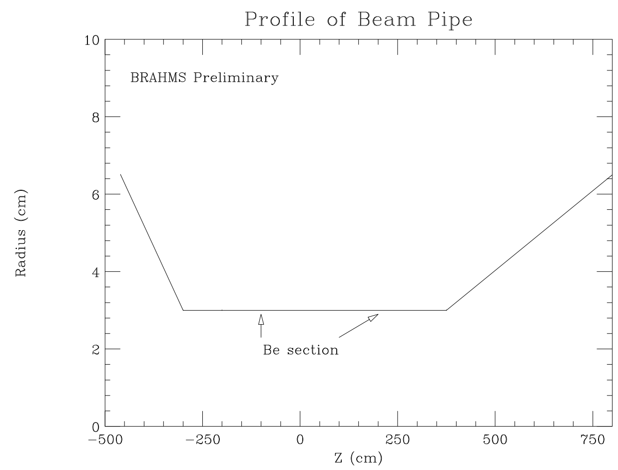

Figure 5.3: This plot illustrates the beam pipe profile for the BRAHMS intersection region. The beam pipe is stainless steel except for a 3-meter beryllium section near the beam crossing point ($z = 0$). The two conical sections expand the radius to the standard RHIC radius.

5.4 Beam Pipe

The beam pipe design in the intersection region has important consequences on the performance of the experiment. The forward spectrometer and D1 are being designed to have acceptance for particles produced at 2 degrees. A clearance of 1 cm between the coil and the 2 degree trajectories is required to eliminate the coils as a source of background trajectories due to secondary interactions. The coil and the retaining plate have a combined thickness of 3.75 cm leaving a total transverse distance of 4 cm to the center of the beam pipe. 1 cm of this space is intended for clearance, which establishes the maximum radius of 3 cm for the beam pipe. The simplest geometry for the beam pipe which would meet the need of the experiment would require the 6 cm diameter to extend from the intersection point to about the middle of D1, ie. about 3.5 meters. The diameter of the beam pipe along magnet D2 and the back portion of D1 is being examined in conjunction with the shielding design to reduce produced secondaries in the experiment's detectors. A preliminary diagram is shown in Fig. 5.3.

The diameter of the beam pipe can affect several aspects of the accelerator performance. The beta function shown in Fig. 11.6 of the RHIC Design Manual demonstrates that a 3 cm radius beam pipe near D1 is a larger aperture relative to the beam than the 5 cm radius pipe in D0. The vacuum achievable in the intersection region will be dependent on the beam pipe design. The ability of the pumping system to provide sufficient vacuum will need evaluation in conjunction with the design. We have addressed these issues with RHIC personnel and concluded that a beam pipe design which meets the machine and experimental parameters should be readily achievable.

5.5 Utilities

The experiment will require AC power and cooling water. The total AC power for the experiment is about 3MW. This is dominated by the 2 MW necessary for the DC power supplies. The experiment estimates requirements of 0.2 MW of clean power provided by an isolation transformer and 0.1 MW of power for lights, motors, fans, air conditioning, etc. Until the design is more complete we have added 30% contingency to this power request. The experiment will require 250 GPM of cooling water for the magnets and power supplies. The system should have at least 150 psi and handle a temperature rise of 75 degrees fahrenheit.

5.6 4 O'clock Facilities and Improvements

The items discussed in this chapter constitute a baseline facility for the BRAHMS Experiment. Discussions with the RHIC organization indicate that these baseline facilities are reasonable and will be provided by the RHIC organization at the IR in which the experiment is sited. We have discussed the transition of responsibilities for various systems to ensure that the appropriate costs are included in the BRAHMS budget. These considerations have been included in the budget and schedule given in Chapter 10 for BRAHMS.

We have suggested several possible improvements to the 4 O'clock area be considered which would enhance this area for BRAHMS, the accelerator systems, and other potential experiments. The experiment has discussed these options with the RHIC organization in preparing this CDR for BRAHMS. Although initial budgetary constraints may not allow these improvements to occur before initial machine operation, the option to implement these upgrades after the startup of the machine should be considered in the design and layout of the facility.

Removing the RF from this intersection region will greatly increase the versatility of this intersection region for BRAHMS and other potential experiments. It is expected that measurements in conjunction with the RF cavity test will determine whether BRAHMS and the storage RF can compatibly occupy the same intersection region. The present RF installation planned at 4 O'clock will certainly limit the upgrade options to BRAHMS and other experiments which might be able to use this area in the future.

A building and crane over the intersection region would be a valuable asset to the area. We suggest that an option to cover a portion of the IR with a building (approx. 100 ft wide) and a 40 ton crane be considered. The building and crane could be extended when future upgrade funds become available. Without this option, it will be nearly impossible to remove the roof shielding once the BRAHMS Experiment has been constructed. The decreased cost of installing shielding, weather-proofing the shielding, experimental installation, and accelerator component installation may make this an intelligent cost effective option.

The addition of an access road to the outside of the 4 O'clock area would increase the versatility of the area. Options to site the experimental counting house and/or power supply house to the outside could then be considered to prevent congestion on the inner side. This may also aid in area construction and reduce interference during the construction phase of the machine and experimental components.

5.7 2 O'clock Facility

The 2 O'clock intersection region is a potential site for BRAHMS. A layout of BRAHMS in the 2 O'clock experimental area is shown in Fig. 5.4 for illustrative purposes. The experiment fits within the allotted space, although there are several locations where the rear of the spectrometers are in close proximity to walls. If sited at 2 O'clock, the experiment would need to carefully control the final design length of each spectrometer. A crane support and existing sheet metal wall would require modification to allow the forward spectrometer to reach 20°. We have discussed the issues of siting BRAHMS at either 2 or 4 O'clock with the RHIC organization. They are considering the benefits of either location in the context of both BRAHMS and the overall collider program.

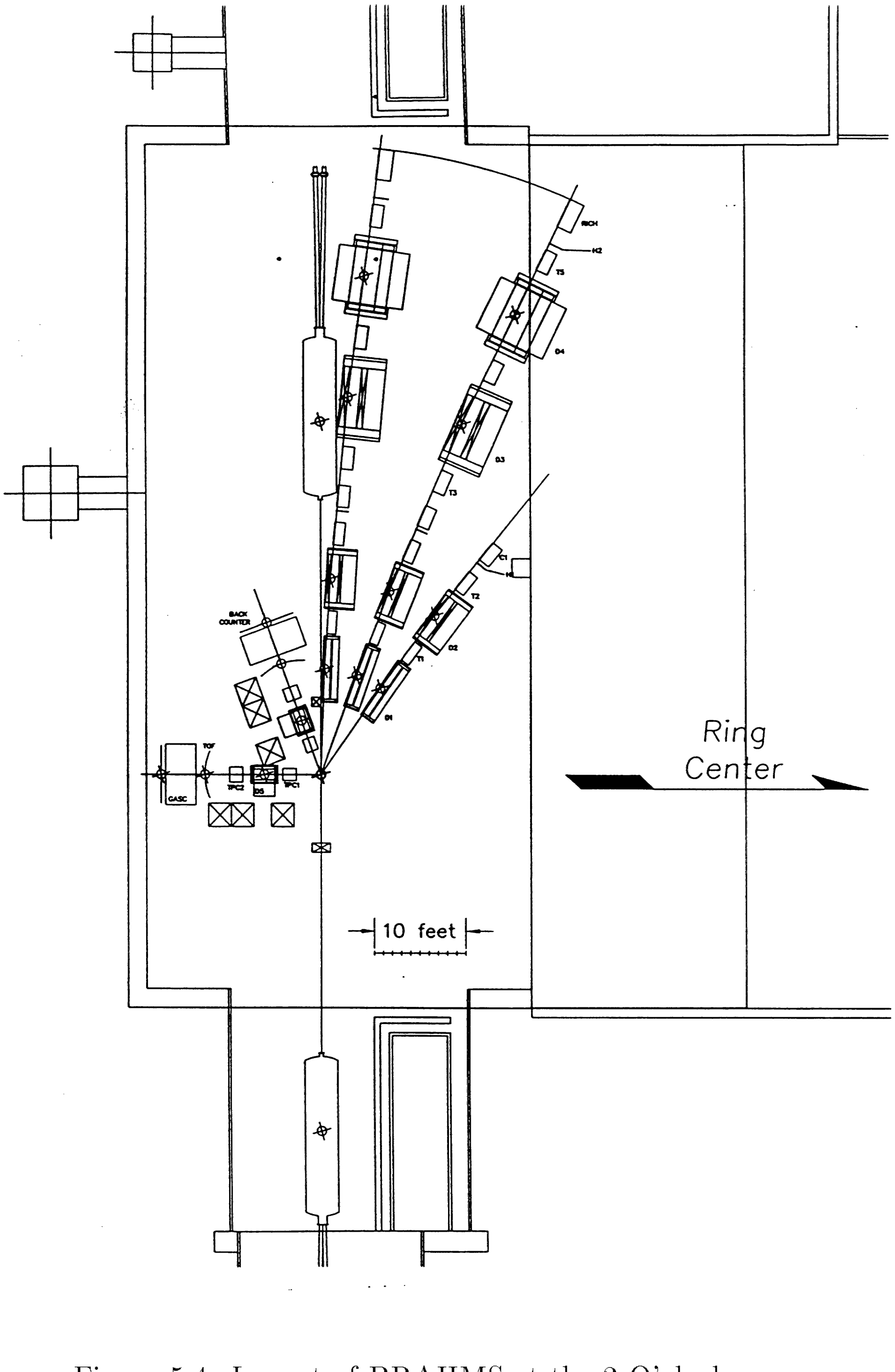

Figure 5.4: Layout of BRAHMS at the 2 O'clock area.